PROCEDURE: DF_STAR_Forwarding_Proc(*fr*, *p*), also see Fig. 22

```
Begin
  If fr is encapsulated                       /* Case 9.1: fr is an encapsulated frame */
    s := src(uncap(fr))
    t := dst(uncap(fr))
    pload := pld(uncap(fr))
    if dst(fr) ≠ addr(self)                   /* self is not the proxy destination */
        drop the frame
    else
        ESL_Search_Proc(s, t, pload)
    endif
  else                                        /*Case 9.2: fr is not encapsulated */
    s := src(fr)
    t := dst(fr)
    pload := pld(fr)
    if ESL(self, t) is not found              /* Case 9.2a: ab(t) is unknown */
        FD_Search_Proc(s, t, pload, p)
    Else if ESL(self, s) = self               /* Case 9.2b: ab(s) = self */
        If ESL(self, t) = self                /* ab(s) = ab(t) */
            FD_Search_Proc(s, t, pload, p)
        If FG_R(self, ESL(self, t)) = -1      /* ab(t) is an ancestor of ab(s) */
            FD_Search_Proc(s, t, pload, p)
        Else if FG_R(self, ESL(self, t)) = -1 /* ab(t) is an descendant of ab(s) */
            FD_Search_Proc(s, t, pload, p
        else                                  /* ab(t) and ab(s) are on different branches */
            ESL Search Proc(s, t, pload)
    Else                                      /* Case 9.2c: ab(s) is unknown or ab(s)
                                              ≠ self */
        FD_Search_Proc(s, t, pload, p)
    endif
  endif
end
```

Pseudocode 9: DF_STAR_Forwarding_Proc

VI. Update

In the IEEE 802.1D standard, the root bridge sends a BPDU message periodically to update the spanning tree. When a bridge detects a topological change, it sends a Topology Change Notification BPDU frame to inform other bridges to recompute the spanning tree. End station information is updated by a timeout mechanism. Each entry in the FD is assigned a timer and the information is forgotten when the timer expires.

The STAR Bridge Protocol keeps topological information in the BF Table, which is built upon the spanning tree and eligible crosslinks. Therefore, if either the tree changes or any crosslink changes, the BF Table must be recomputed. The procedure for detecting any change of the spanning tree is available in the above-mentioned standard. The BF Table is recomputed after the spanning tree becomes stable again. The mechanism of detecting crosslink failures is described in Section I.F. A STAR bridge transits back to the Tree Learned state when a crosslink fails. In the mean time, the STAR bridge executes the standard forwarding process and the standard learning process instead of the new ones to forward data frames.

In the STAR Bridge Protocol, the information needed for reaching end stations is kept in the ESL Table and the FD. They both time out in the same way as the FD in the old bridges do. This is necessary because no bridge can detect the relocation of an end station. Since bridge addresses do not change frequently, the BA Table does not need to be timed out.

VII. Performance

In this section, we analyze the storage, message complexity, and path length of the STAR Bridge Protocol.

VII.A Storage

Each old bridge keeps only one table for forwarding, which is the FD. One entry is necessary for each known end station. Therefore, the space required is $O(|M|)$, where M is the set of all end stations in the extended LAN. In addition to an FD, there are three new tables in each STAR bridge: BF Table, ESL Table, and BA Table. Table 5 is a summary of these tables in STAR bridge n.

Name	Content	Space Required
BF Table	$<n', F(n, n'), next(n, n'), FG\_R(n, n')>$, $n' \in B\backslash\{n\}, F(n, n') \in P(x), next(n, n') \in B\backslash\{n\}$	$O(\|B\|)$
ESL Table	$<s, ab(s)>, s \in M, ab(s) \in B$	$O(\|M\|)$
BA Table	$<n', addr(n')>, n' \in B\backslash\{n\}\backslash W_B(n)$	$O(\|B\|)$
FD	$<s, f(n, s)>, s \in M, f(n, s) \in P_T(x)$	$O(\|M\|)$

Table 5: Storage Requirements in STAR Bridges

After the STAR learning process has been executed for some time and old entries in the FD have been timed out, an end station *s* appears in both the ESL Table and the FD of STAR bridge *n* only if *ab(s)* = *n*. Therefore, the total memory needed for the ESL Table and the FD in STAR bridges together would be about the same as in the old bridges. We do need extra space for the BF Table and the BA Table. However, as the number of entries of both tables is at most $|B|$ which is far less than $|M|$, we can conclude that the storage requirement in a STAR bridge is comparable to that in an old bridge.

VII.B Message Complexity

In the IEEE 802.1D standard, BPDU frames are sent periodically to build and maintain a spanning tree. In the STAR Bridge Protocol, SBPDU frames are introduced and they are described in Section I.D. Hello SBPDUs are sent on eligible crosslinks only and a Hello SBPDU frame will not propagate beyond the crosslink that it is sent on. Therefore, Hello SBPDUs do not put extra message overhead on tree links. Distance Vector Change Notification SBPDUs are sent only when distance vectors have to be recomputed and they are sent over the spanning tree. As a result, under stable configuration, there will normally be no Distance Vector Change Notification SBPDUs generated. Table 6 summarizes the format of Distance Vector Computation SBPDUs and Station Location Announcement SBPDUs. The path finding process generates Distance Vector Computation SBPDUs and the STAR learning process generates Station Location Announcement SBPDUs.

For each Distance Vector Computation SBPDU frame generated by the path finding process, there is at most one recipient on each port. Obviously, there should be more DVRecord frames than other Distance Vector Computation SBPDU frames in this process. The number of DVRecord frames needed for each pair of STAR bridges depends on the length of the enhanced forwarding path between them. The path length is bounded by the diameter of the tree. The number of messages generated by the spanning tree is related to the diameter of the tree too. Therefore, we can conclude that the number of messages generated by the path finding process is about $|B|$ times the number of the messages needed in building the spanning tree. The path finding process will not generate any DVRecord frame after building the BF Table. Nevertheless, the root bridge will keep on generating BPDU messages periodically after the spanning tree has been built. Therefore, for a stable bridged LAN, the extra number of messages generated by the path finding process is negligible.